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ABSTRACT

This study attempts to identify relative contributions of certain attitudinal variables to mathematics avoidance. The primary objective was to discover the most salient predictors of mathematics avoidance (MA). Nine Fennema and Sherman Mathematics Attitude Scales (1960) were revised for use with a general population, and a similarly worded Likert-type scale was constructed and validated to measure the dependent variable, mathematics avoidance. Over 500 subjects from a variety of age, occupational and geographical groups responded to the survey instrument. A stepwise multiple regression was performed on the scale scores, yielding five significant predictors of MA which accounted for nearly 82% of the total variance. The predictors, in order of importance, are: effectance motivation (defined as a problem-solving mind-set), self-confidence in learning mathematics, perception of the usefulness of mathematics, mathematics anxiety, and the factors relating to father. A discriminant analysis was performed to locate the sex differences in the mathematics scales, following the discovery of a significant interaction between self-confidence and gender in MA. Results are interpreted in terms of number helplessness, an analog of learned helplessness. Implications for intervention and remediation are presented. (Author/MP)

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CORRELATES OF MATH AVOIDANCE RESPONSIBLE FOR FILTERING INDIVIDUALS FROM MATH/SCIENCE AREAS

by

Carol Chisholm

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ABSTRACT

Research concerning the math experience has indicated that attitudes toward numbers and their use may be responsible for the avoidance of mathematics and number use. The present study attempts to identify the relative contributions of these attitudinal variables to the avoidance of mathematics. The primary objective was to discover the most salient predictors of math avoidance (MA). Nine Fennema and Sherman Mathematics Attitude Scales (1960) were revised for use with a general population, and a similarly worded Likert-type scale was constructed and validated to measure the dependent variable, math avoidance. Over 500 subjects from a variety of age, occupational and geographical groups responded to the survey instrument. A stepwise multiple regression was performed on the scale scores, yielding five significant predictors of MA which accounted for nearly 82% of the total variance. The predictors, in order of importance, are: effectance motivation (defined as a problem-solving mind-set), self-confidence in learning math, perception of the usefulness of mathematics, math anxiety, and the factors relating to father. A discriminant alalysis was performed to locate the sex differences in the math scales, following the discovery of a significant interaction between self-confidence and gender in MA. Results are interpreted in terms of number helplessness, an analog of learned helplessness. Implications for intervention and remediation are presented.

(1) Number Helplessness: A Study of the Affective Correlates of Mathematics and Number Avoidance

(2) Personality:measurement;Clinical;anxiety; Helplessness

(3) The Problem

For a segment of our population, the attempt to avoid using numbers assumes serious proportions. Among students, this may take the form of choosing a course of study requiring no mathematics and among the general populace, the effort includes relying on others for even simple calculations. A large body of research in psychology, education, and mathematics has addressed the problem, but the literature is poorly synthesized. However, it seems that the study of the number experience has been approached from three perspectives: math performance or achievement, attitudes toward numbers and their use, and, particularly, math anxiety, which sometimes appears to be synonymous with math avoidance. Unfortunately, remediation and research have proceeded without utilizing all of the available information.

The present study attempted to define and measure the construct of math avoidance (MA) and determine the primary predictors from the larger net of variables. A primary objective was the discovery of the relative contributions made by the correlates, so that the most influential ones might provide the basis for remediation and prevention strategies. The affective variables measured were: math anxiety, confidence in learning math, relationships with father bearing on number use, analogous relationships with mother, interrelationships with teachers in

mathematics, attitudes toward success in using numbers, perception of math as a domain suitable for males only, perception of the usefulness of math, and effectance motivation. Effectance motivation was defined as a dimension ranging from passive inaction when confronted with a numerical task to active experimentation with numbers, and is a problem-solving mind-set. In addition to the attitudinal correlates, the study examined demographic variables that might differentiate between avoiders and non-avoiders, such as occupation, field of study, sex, and age.

(4,5) Methodology

The nine predictors of MA were assessed by scales developed and validated by Fennema and Sherman (1960). These Likert-type scales permitted responses on questions of attitude on a scale of one (strongly agree) to five (strongly disagree). An example from the male domain scale is: "Girls who enjoy studying math are a bit peculiar." The scales were constructed for student use; it was necessary to modily some of the wording for use with a general population.

A scale for measuring MA did not exist. Therefore, a scale with wording similar to the other scales in Likert form was constructed, with the assistance of experts in the field of education, psychology and child development, to assess the variable. This scale contained 24 negatively-and positively-worded items. Over 100 students and faculty members completed

the scale, and item-to-scale correlations were computed to identified the questions most relevant to the construct of MA. A sample from the new scale read: "I avoid graphs and tables in the newspaper."

Each of the ten scales contained six positively and six negatively worded questions. The 120 questions were randomly assigned places on four different forms of the survey instrument, and spaces were provided for demographic information and global responses. The forms were administered to more than 500 people in a variety of age groups, in different geographical locales, and in different occupations. Responses on each of the ten scales were summed in such a manner that positive answers received high scores, and a single score for each scale was tallied. These numbers, with coded demographic information, were used in a multiple regression to determine relative contributions of each variable to the avoidance measure. Additionally, a discriminant analysis was performed to locate differential patterns of response by sex grouping.

(6,7) Results and Conclusions

Five significant predictors of MA emerged from the regression. The best predictor, effectance motivation, accounted for a majority of the variance (74%). With the next three significant predictors, confidence in learning math, perception of the usefulness of math, and math anxiety, a picture emerges of the avoider. Like the victim of learned helplessness, he/she appears passive, unmotivated,

lacking in confidence, anxious and unable to see the usefulness of responding.

Other minor, though significant, relationships were the relationship of the father variable with avoidance, and an interaction between sex and self-confidence with avoidance. The discriminant analysis indicated that males and females exhibit similar patterns,with females showing less self-confidence, more desire for competence, and less evidence of seeing math as a domain for males only.

Results of the study indicate a hierarchy of variables highly correlated with MA. The present approach to the area has been reduction of math anxiety through clinical intervention. Our results show that math anxiety is highly correlated with MA, but is not the best predictor. Because of the emergent patterns among predictors, we hypothesize that, as in learned helplessness, the anxiety is a symptom that will disappear once forced responding (i.e., confronting math in a non-threatening, errorless discrimination setting) has overcome the initial avoidance. Thus our model is not merely descriptive, but suggests remediation and is empirically testable.

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CHAPTER 1

Mathematics is a pervasive and omnipresent facet of contemporary experience. Nearly all areas of endeavor require the use and manipulation of numbers. With the acceleration of technology, math avoidance is nearly as difficult and crippling as is avoiding crowds for agoraphobics. There is, however, a mounting body of evidence to indicate that math avoidance occurs frequently within the general population, with serious consequences to the individual and to society (Donady & Tobias, 1977; Nevin, 1973; Pearson, 1980; Poffenberger and Norton, 1956; 1959; Tobias & Knight, 1978; Tulock, 1957; Winer, 1972). Research into the phenomenon has proliferated; nonetheless, more questions than answers have been generated. The goal of the following research is to summarize and to integrate the diversity of unrelated facts in the math avoidance literature.

Definitions of Math Avoidance

Research on the topic of math avoidance (MA) remains unsystematized and unsynthesized, perhaps because of the lack of a coherent, generally accepted definition of MA. One reason why a definition has not emerged may be the general propensity to consider it self-evident. Gough(1954) for example, writes that the term "mathemaphobia" has no need

of definition, thus indicating it to be a well-known phenomenon in the world of education. Lazarus (1973) gives Jerrold Zacharias credit for coining the word "mathophobia," and states that, while unnamed, it has long been recognized by all. Moreover, verbal definitions of MA such as "an impeditive, irrational dread of mathematics," (Lazarus, 1970,p.16) are empirically unverifiable.

The Study of Math Experience

The study of math experience has been approached from three perspectives: 1) math anxiety; 2) performance in math courses; and 3) attitude toward the world of numbers. Existing studies of MA, however, may not be measuring the same thing. Although Pearson (1980), for example, equates anxiety and avoidance, it is more likely that anxiety is a correlate of, not a synonym for, MA. Anxiety in the presence of numbers does not automatically signal avoidance of mathematics. In the past, instead of anxiety, differences in math performance have been used to explain MA (Bonser, 1906, as cited in Wozencroft, 1963). Over 30 years of research has failed to reveal any cross-cultural differences (Tulock, 1957) and though Stafford (1972) postulated genetic differences in ability related to a sex-recessive gene, there is no conclusive evidence to indicate that aptitude, phylogenetically programmed, is a determining factor of MA. Despite recent evidence of a sex difference among the most capable

math students, (Benbow & Stanley, 1980), Gray (1980) asserts that too little is known about mathematical reasoning to conclude that genetics plays a major part in math performance. Aiken (1970a) discussed "attitude" as a moderator variable in MA and Bassham (1962) called it a "catalyst." Accordingly, "affective components," such as anxiety, attitudes toward success and similar feelings were correlated with achievement and thus were seen as catalysts for avoidance.

Measures of the Correlates of Math Avoidance

Affective variables proposed to be highly correlated with MA have been effectively measured (Michaels & Forsyth, 1978). Available math attitude scales include Thurstone scales (Dutton, 1954), Likert-type scales (Dutton & Blum, 1968; Fennema & Sherman,1976), and others of the "semantic differential" format (McCallon & Brown, 1971; Scharf, 1971). The Rocky Mountain Behavioral Institute published the Math Anxiety Rating Scale (MARS), (Suinn, 1972; Richardson & Suinn, 1972) to measure math anxiety. Fennema and Sherman published Likert-type scales for math anxiety, and for several other of the generally investigated correlates of MA, including: 1)confidence in learning math 2)relationship with mother 3)relationship with father 4)interactions with teachers 5)attitudes toward success in math 6)perception of math as a male domain 7)perceived

usefulness of math 8)effectance motivation. Unfortunately, however, the relative contribution of scaled variables predictors of math avoidance has never been determined.

Correlates of Math Avoidance

The lion's share of the MA research has focused on the identification of attitudinal variables (Abrego, 1966; Aiken, 1963; 1970a;1972;1976; Aiken & Dreger, 1961; Anttonen, 1969; Bassham, Murphy & Murphy, 1964; Bendig & Hughes, 1954; Billig, 1944; Callahan, 1971; Carey, 1957; Dutton, 1954; 1956; Dutton & Blum, 1968; Fedon, 1958; Fellows, 1973; Johnson, 1957; Knaupp, 1973; Hill, 1967; Lindgren, 1964; Malone & Freel, 1954; McCallon & Brown, 1971; McCausland & Stewart, 1974; Michaels & Forsyth, 1978; Neale, 1969; Phillips, 1973; Poffenberger & Norton, 1956; 1959; Reys & Delon, 1968; Roberts, 1969; Scharf, 1971; Smith, 1964; Stent, 1977; Stephens, 1960; Stright, 1960). Although Neale's (1969) survey of many correlational studies led to the conclusion that achievement in mathematics did not account for much of the variance in avoidance of mathematics,it is also true that students who dislike math because they do poorly tend to avoid further contact (Knaupp, 1973). In addition, longitudinal research by Brush (1980) indicated that "perceived ability" is a consistent predictor of terminal level of math coursework. Thus the "ability factor" is thought to be largely a matter of the student's self- perception as either

able or unable. This attitude is thought to take form between pre-school and approximately ninth grade (Anttonen, 1969). Although the current research reveals no differences in attitude towards math between the sexes through the early elementary grades, and student attitudes generally deteriorate thereafter, females' attitudes worsen more rapidly, and become more negative than males'. (Aiken, 1970a; Sherman,1967; Wozencroft, 1963). Such negative attitudes, once formed, can be changed, but only over extended periods of time and with great effort (Knaupp,1973). Attributing ones' difficulties to "realistic causes" has been shown to alleviate pathological avoidance of math (Winer, 1972). There appears to be an interaction between attribution and sex. Fennema (1974) noted an attributional element in the study by Crandall and associates; girls and boys attributed problem solving success to fate if they generally had a low achievement level. Competent boys attributed their success to their own abilities whereas competent girls tended not to believe themselves capable.

A second well-studied correlate of MA is math anxiety (Betz, 1978; Donady & Tobias, 1977; Dreger & Aiken, 1957; Gordon & Sorensen, 1955; Gough, 1954; Hendel & Davis, 1978; Kogelman & Warren, 1978; Lazarus, 1974; Morris, Kellaway & Smith, 1978; Naiman, 1973; Naylor & Gaudry, 1973; Nielsen, 1979; Parente' & Chisholm, 1980; Pearson, 1980;

Richardson & Suinn 1972; Ruebush, 1960; Suinn, Edie, Nicoletti & Spinelli, 1972; Tobias, 1976; 1978; Tobias & Knight, 1978; White & Aaron, 1967). Aiken (1957) considered math anxiety a "relative" of attitudes in general, but more "visceral and exciting." Tobias (1976) labelled it an "I can't" syndrome. Dreger and Aiken (1957) called it "number anxiety" to differentiate it from general anxiety which they believed to be a generally unrelated phenomenon. They viewed number anxiety as a disruptive defense reaction which conflicts with behaviors needed in problem solving, and, as such, antithetical to accomplishment (Ruebush, 1960). Betz (1978) found a high incidence of math anxiety among college students. The problem was more prevalent among females with inadequate quantitative backgrounds. Math anxiety was negatively correlated with math achievement test scores, and positively correlated with state and trait anxiety measures. Moreover, there appear to be two components to the anxiety: worry and emotionality,a physiologically defined state (Morris, et.al.,1978). This line of research has led to the development of anxiety rating scales used to predict who will become worried in performance situations with numbers.

Parental correlates of MA proposed include expectations, encouragement, and attitudes of the mother and father (Aiken, 1970a). The hypothesis assumes that the child models the same sexed parent and internalizes that role. However,

Hill (1967) found this type of modeling operative when the parent of either sex communicates the appropriate cultural role to the child. That is, either parent can make the child of either sex cognizant of her/his role. Parental attitudes toward math typically involve an expectation for the son to achieve. Mother's function is particularly complex and does not appear to be identical to that of the father. Similarity of mother-son attitudes toward math was found greater than similarity of father-son attitudes, especially where fathers were not perceived as warm individuals, or as individuals sharing full participation in the child rearing (Hill, 1967). Poffenberger and Norton (1959) found that college freshmen with negative attitudes toward math believed their parents expected them to get lower grades in math. In 1963 the same researchers reported a significant correlation between parent attitudes, expectations, and student achievement. Another way in which parents may influence offspring is through lack of encouragement which negatively influences children's attitudes toward math, according to Nielsen (1979). Moreover, parent attitudes appear to transfer to offspring (Lazarus, 1974; Aiken, 1976).

Fathers are believed to have a different function than mothers in mathematical development of children. Students generally appear to feel that mothers' attitudes toward math are more negative than those of fathers'.

Poffenberger and Norton (1959) looked at children's perceptions of parents functioning in MA, and found that 42% of college freshmen believed their fathers liked math very much, but only 11% believed the same of their mothers. The father is often cited as the critical parent for sex role learning in the son (Hills, 1967). Concerning math avoidance, Carlsmith (1964) discovered that boys whose fathers were absent for a long period during the child's early life had higher verbal/quantitative ratios on College Entrance Examination Board and Scholastic Aptitude Tests, while boys with the highest such ratios often had dominating, tyrannical, or non-interacting fathers. Poffenberger and Norton (1959) found that negative math attitudes of freshmen college students correlated with perceived negative math attitudes of fathers. Of students who characterized their relationships with fathers as "distant." a majority believed their fathers disliked math (Aiken, 1976).

The involvement of teachers in the production of MA has received little scientific attention. Poffenberger and Norton (1956) stated that avoiders often report that one teacher caused that avoidance. Gough (1956) stated that interviews with students reveal a single teacher may initiate a pattern of negativism which reflects the teacher's own attitude, lack of mathematical competence, poor teaching skills, or use of inadequate curriculum.

Ambivalence toward success may also predict later math avoidance. Aiken (1976) found orientation toward success in math for college students negatively correlated with math avoidance, with greater orientation toward success predicting less avoidance. Orientation toward success, for example, seems to have worked in the national call to excellence after the launching of the Russian Sputnik; the overall United States academic standards were raised, but only males experienced increased interest and achievement in mathematics (Poffenberger & Norton, 1963).

Ernest (1976) believed the perception of math as a masculine pursuit correlates highly with MA in some people. Those individuals who do not identify with exclusively masculine endeavors and see math as such an endeavor will avoid it. However, Milton (1957) found that male/female differences in attitude toward the masculinity of math tended to disappear when the masculinity/femininity trait, as measured on the MMPI, was controlled. He concluded that the reported differences in these attitudes reflect only culturally defined behaviors, attitudes, and motivations. Lambert (1980) found no correlation between arithmetic proficiency and masculinity of interest pattern for either sex and concluded there is no basis for the belief that ability in math is a masculine trait. Nonetheless, when individuals hold such a belief, it may predispose them to avoid math.

Another proposed correlate of MA is perceived usefulness. An individual may avoid math if not convinced of its importance in life. According to Malone and Freel (1954), the perceived utility of math is indeed correlated with positive math attitudes. Seeing the usefulness of math may help the frustrated student persevere to success (Callahan, 1971). Perceived utility of math in earning a living correlates with achievement and interest (Hilton & Berglund, 1974). Many students view math as irrelevant because available instructional materials often seem highly abstract (Aiken, 1970a). By structuring the material to be learned into meaningful units and problems relevant to the student, both performance and interest were improved in studies reported by Wilson (1961) and by Leder (1974).

The relationship between math avoidance and "effectance motivation" has also been investigated (Fennema & Sherman, 1976; Tulock, 1957; Aiken, 1973). Effectance motivation is a problem solving attitude inferred from behavior that shows an exploratory attitude, and ranges from lack of involvement to the seeking of challenge (Fennema and Sherman, 1976). Lack of effectance motivation (EM) for math is thought to be a cumulative, cultural phenomenon, according to Poffenberger and Norton (1959). Neale (1969), however, has not found empirical support for this relationship. It is per-

haps safe to conclude that the relationship between MA and EM is unclear.

A number of other factors have been proposed as relevant covariates of MA but have not been proven to be highly correlated with MA. Age, IQ, and temperament have been intuitively offered as factors, but are uncorrelated with MA (Aiken, 1961; Poffenberger & Norton, 1959). Level of maturation may be involved, but has only been implicated anecdotally (Aiken, 1963; Naylor & Gaudry, 1973). "Dyscalcula," the inability to use numbers, is rare, and thus not highly correlated with MA for the general population (Landsdown, 1978; Lazarus, 1974). Although research to date has implicated several factors, they individually account for little of the total variance in MA for the majority of people.

Theories of Math Avoidance

Sells, in her 1973 study of entering freshmen at the University of California at Berkeley found that only 8% of females and 57% of males had the four years of high school math necessary to qualify for the rigorous math and science courses required for 75% of all majors at that university. She hypothesized a "critical filter" of math avoidance in which large numbers of students are effectively screened out of math/science areas because of inadequate background

preparation (Donady & Tobias, 1977; Pearson, 1980). Ernest (1976) found results in agreement at the University of California at Santa Barbara. Other researchers have discussed math avoidance as a critical filter in education and vocational decisions (Bendig & Hughes, 1954; Betz, 1978; Hendel & Davis, 1978; Kogelman & Warren, 1978; Lazarus, 1974; Pearson, 1980; Tobias, 1978; Tobias & Knight, 1978; Tulock, 1957; White, 1970; Wilson, 1961). According to the critical filter model, a series of events and decisions leads to less and less exposure, and finally to avoidance. Examinations may effectively filter out some math avoiders. McClelland (1973) has argued that intelligence tests function to remove students from areas in which they might have opportunities for mastery. The longitudinal study by Brush (1980) found student plans for involvement in math decline from sixth to twelfth grades, which indicates a decline in their perceived mastery level. Lambert (1980) stated that using math achievement test results to "prove" certain students superior fails to take into account past experiences. Thus, although students may have an untrained problem-solving ability which remains unmeasured, they might be filtered out of math situations on the basis of current achievement.

Theories extant in the early twentieth century postulated the existence of a "mathematical mind," the development of which was dependent upon innate factors. If

true, those who believe themselves not to have a "mathematical mind" would be justified in avoiding math (Tobias & Knight,1978). The theory of a mathematical mind is consistent with the critical filter model. Both may explain results of many earlier studies purporting to show male superiority in math, thus perpetuating a stereotypical male "mathematical personality." An early study reporting male superiority in math sampled twice as many females as males; the smaller number of males resulted from the less gifted males dropping out to join the labor force, while all females stayed until grade twelve (Bonser, 1906, in Wozencroft, 1963). Although Eells and Fox (1932) found sex differences in favor of males in 6000 junior college students on math performance measures, most of the differences found were in the group matched for no prior exposure to math. This group represented male and female students with no prior training in mathematics. For those groups with previous math coursework, however, the female/male differences were not important. Current research supports a position of no sex differences in aptitude (Aiken, 1970a; Alexander, 1962; Hendel & Davis, 1978; Keeves, 1973; Landsdown, 1978; Nielsen, 1979; Pearson, 1980; Poffenberger & Norton, 1973; Sherman, 1967). The only notable exception to this is the controversial work by Benbow and Stanley at Johns Hopkins (1980). In that research, junior high school students at the top 2 to 5% of

their grades according to Scholastic Aptitude Tests, were compared. The researchers found that boys outperformed girls, particularly after further study in mathematics. Generally, females show superior performance in elementary grades, and males from grade 12 and above. (Aiken, 1970a; Hilton & Berglund, 1974). Brush (1980) reported ability is a predictor of avoidance, with highly able students taking more math courses. The Benbow and Stanley (1980) work shows a sex difference in math performance from seventh grade upward, in favor of males. This study looked at gifted students, and measured achievement on the College Board's Scholastic Aptitude Tests. As boys continued to take more math courses, differences grew.

There is some evidence to support the stereotype of a "Math Brain" as male. One area in which males consistently score higher than females is spatial perception, and some researchers have postulated this to be the reason for male superiority in math performance (Garai & Scheinfeld, 1968). Although spatial visualization is useful in subfields such as geometry, it is basically a specialized ability, and not a general analytic ability function (Ernest, 1976). The cause of differential performance on spatial tasks is also unclear. Tobias (1978) observed that some researchers postulated the cause to be early left hemispheric lateralization of the brain in males, while others felt that males were superior

because of later left hemispheric lateralization. Some suggested that girls lateralize earlier and concluded that this causes them to miss a crucial stage of spatial visualization. However, many researchers who believe boys lateralize earlier (by age 6) have postulated the opposite; that earlier lateralization is better for developing spatial visualization. Sherman (1967) reported that improvement of these skills may be obtained from practice in activities traditionally associated with boys in our society, such as target practice, model building, and "tinkering" with cars. She further stated that spatial abilities, which mature between 11 and 15 years of age, coincide with the onset of the widening gaps between males and females in math performance. Thus she concluded that relationships between many variables and arithmetic achievement may be mediated by sex typed spatial learning. The theory of a phenotypical mathematical personality remains to be adequately tested.

Modeling Theories of Math Avoidance

Modeling theories of MA assert that perceptions of parents' attitudes toward math shape development of the child's attitudes. Fathers who perceive math as a male area have higher expectations for their sons in math than those who do not, according to Hill (1967). Planck and Planck (as cited in Aiken, 1970a) reported a "perceived need for aggressiveness" in mathematics, thus identifying it with mas-

culinity. Although one study of math majors found females in that group to be significantly more feminine than female non-math majors, (Milton,1959) math has been related culturally to the traditional male role (Fennema,1975).

Types of Modeling

Another theory implicates the mother as the cause of MA in her offspring. Many mothers are themselves math avoiders, and thus effect avoidance in children. (Poffenberger & Norton, 1956). Modeling theory assumes that MA is passed on through learning and not phylogenetically programmed (Gough, 1954). Aiken (1974), however, found little correlation between mother's achievement or attitude and the avoidance level of her child. Luchins (1979) reported that the current literature seemed confusing. Reports indicate that overprotective mothers often rear sons whose achievement is poor in math (Aiken, 1970b). Poor achievement has been stated to result from a failure of the underachiever to adequately detach from mother. This explanation of math avoidance, however, ignores the fact that in Freudian theory, displacement of sexual/aggressive conflicts that signals detachment from mother supposedly comes at an earlier age than that at which math differences begin to appear.

The function of the father has also been implicated as a causal factor in MA. Hills (1967) postulated maximal

development in math as a function of early identification with mother followed by later relationship with father in which father's expectations are internalized. This optimal development is postulated to result from father's efforts to socialize the child. Development of attitudes which may later cause MA may be part of the variation attributable to father (Aiken, 1976; Carlsmith, 1964; Poffenberger & Norton, 1959).

Teachers are important role models in the development of math attitudes. Boring teachers, or those who communicate lack of competence produce students with negative attitudes (Callahan, 1971; Dutton, 1955; Landsdown, 1978). Wilson (1961) identified poor teaching as a major factor in MA, arguing that the poorly taught student may be unable to achieve sufficient mastery to develop confidence and satisfaction. Poor teaching may result from inadequate formulation of current curricula which do not adequately reflect the developing capabilities of the child (Lazarus, 1974; Tobias, 1978). One example would be the introduction of fractions early in the elementary grades, when children have not developed those concepts necessary to understand fractional operations. In addition, the attitude of the teacher may have some relationship to MA in students. Although Phillips (1973) found teacher attitudes uncorrelated with student attitudes, he found them positively correlated with student

achievement. In contrast, Knaupp (1973) however, did find teacher and student attitudes positively correlated. In a related study, Aiken (1970a) reported positive correlations between student attitudes and their reported perceptions of the attitudes of their math teachers. Elementary teachers are reported less positive in attitudes toward math than are high school teachers, and Aiken (1970a) reported at least one-third of prospective elementary teachers stated they were fearful of math and lacked understanding of it. As an example of the confusion in the literature, note that although Delon and Reys (1968) found that 40% of prospective teachers had negative attitudes in their survey, Smith (1962) found 88% to be neutral or positive in attitude. Bassham (1962) attributed 25% of the variability among student efficiency in using problem solving attitudes to teacher understanding of the concepts being taught. Teacher attitudes appear to be important also in developing student attitudes and abilities. The teacher may activate his/her own prophesies in the classroom. One who perceives a student as capable will urge "perseverance" at the point of discouragement, while one who sees the pupil lacking ability permits the student to give up (Winer, 1972). In addition, some cues provided by teachers may be more stimulating to females, such as demands for conformity (White & Aaron, 1967). Ernest's 1976 study found 41% of teachers believed boys generally did better than girls in

math; not one felt girls did better. The remaining 59% felt the sexes were equally competent. Such beliefs might activate sexist expectations with differential expectations by teachers leading to differential reinforcement (Fennema,1974;Nielsen,1979).

Desire to be competent in math is another attitudinal correlate of math avoidance. Some people may not be sure they desire competence in mathematics. This ambivalence may be partly a function of peer evaluation of math as an unpopular subject in which to excel during the critical junior high school years. Aiken (1976) found college students to be attracted to others with the same or similar attitudes toward math. A student who sees that his friends do not value achievement in math may avoid it.

Learned Helplessness Theory

One hypothesis of MA comes from the learned helplessness research (Seligman, 1975; Parente' & Chisholm, 1980). Seligman (1975) gave the name to the phenomenon. He described it as that state resulting when animals learn that outcomes are unpredictable and out of their control. The symptoms of the syndrome include deficits in motivation, understanding and emotional affect. This phenomenon was tested and found to generalize to humans who find themselves unable to control their lives in some way. For individuals who find

manipulation of numbers out of their control, helplessness may result.

Winer (1972) noted that low achievement motivation developed with the growth of causal attributions of success and failure . Abramson and Seligman (1878) reasoned that success is viewed as luck to the math avoider, who feels, moreover, that failure is unpredictable and out of his/her control. Abramson and Seligman (1976) discussed the implications of attributions assigned to failure. If one fails, the failure may be attributed to stable, internal, global factors; or failure may be attributed to unstable, specific and external ones. Perceiving the first triad of factors may result in a learned helplessness mind set. The learned perceptions of self as helpless in using numbers may cause MA (Bassham, 1964; Parente & Chisholm, 1980; Winer, 1972). Poffenberger and Norton (1959) stated that positive and negative concepts of self regarding math ability are well established during early school years, are resistant to change, and may activate self-fulfilling prophesies. Low self-confidence has been associated by Kempler (1962) with problem solving rigidity that makes math a negative experience, and it can lead to anxiety and thus cause MA. Low self-confidence can result from early memorization instead of concept development, go through a latency period, and with unpreparedness to understand later concepts, lead to even

lower self-confidence (Lazarus, 1974). Females appear disproportionately afflicted with lower self-concepts (Ernest, 1976; Fennema, 1974). Math avoidance self-perpetuates as opportunities to achieve are avoided and the negative self-perception becomes increasingly ingrained. The math avoider is initially punished for attempting to learn math, and remedial skills deteriorate with disuse, leaving the individual in a state of helplessness (Donady & Tobias, 1977).

Clearly, the MA literature abounds with generally unintegrated facts. Much theory has been generated, frequently from fragmented correlational studies or anecdotal evidence. Aiken (1970a) noted that much research had progressed without a firm footing on earlier findings. The failure of researchers to adequately search the literature makes it difficult to draw conclusions from the large and fragmented data base. The purpose of the following research was to examine the relative contributions of attitudinal variables such as perception of self and math, effectance motivation, parental and teacher factors, ambivalence toward success in math, and number anxiety, in the multiple prediction of MA.

CHAPTER 2

Design

The study was based upon a correlational design in which scaled measures of the covariates (e.g.,anxiety, "effectance motivation") were used to predict MA. Specifically, a multiple correlation and prediction model was developed to determine which of the covariates were good predictors of MA and which could be legitimately ignored.

Instrumentation

Nine Likert-type scales, constructed and validated by Fennema and Sherman (1960),were selected to measure the correlates of MA. Although developed for use with junior and senior high school students, the scales are suitable (with slight wording modifications) for use with an adult population (Betz,1978) . The nine scales are designed to investigate 1) individual attitudes concerning perceived confidence in learning mathematics, 2) perceptions of mother's and 3) father's roles in interactions with offspring concerning math, 4) relationship with and perceptions of teachers responsible for the individual's numerical education, 5) attitudes toward success in math, 6) opinion of math's usefulness, 7) perceptions of math as a male domain, 8) number anxiety, and, finally, 9) effectance motivation, that problem-solving mind-set. Each scale contains six negatively worded and six positively worded items. Responses are scored

from 1 (strongly agree) to 5 (strongly disagree). By reversing the value of negatively worded items (e.g.,"I'm no good at using numbers"), a uniform value of 5 is obtained for the response that would be considered to have the most positive effect on the subject's math behaviors. In the cumulative total for each scale, a high score indicates a positive attitude; scores range from 12 to 60. Thus, a score of 20 on anxiety would indicate a high level of math anxiety, a negative attitude, and would be hypothesized to have a negative effect on quantitative reasoning.

No scale was available for measuring MA, and it was therefore necessary to construct and validate a Likert-type scale to measure MA. The wording of the new scale was similar to that of the other nine scales, and the 24 item scale showed content validity, having been selected from a pool of statements submitted by persons experienced with test construction, statistics, or the problems of math avoidance. The expanded scale was administered to a group of 100 subjects comprised of psychology faculty and students in a behavioral statistics course at Towson State University. Item to scale correlations were computed, and the six items most highly correlated with the scale from each subset (i.e., negatively worded and positively worded items) were selected as the final math avoidance scale. Table 1 follows with the 12 items listed and item to total correlations given for each

item used in the final questionnaire. Following table 1, the other nine scales, with the wording used in this study, are listed with the six negatively and six positively worded items in order. For this scale, as for the others, positively worded items were reversed, so that a high score denotes a non-avoider.

Babbie (1979) discussed the method of index construction for Likert-type scales, considering it to be both systematic and refined. As evidence, note that the 12 item math avoidance scale yielded a reliability coefficient (Kuder-Richardson 20) of .83. Various correlate scales and the constructed math avoidance scale are presented below:

TABLE 1 : AVOIDANCE SCALE

Negatively worded items:	r
I detest arithmetic and avoid doing it whenever possible.	.6078
I am not good at figures and try to stay away them.	.7012
If I am at a party and some people start trying those math puzzles,I find something else to do.	.5083
I would not enjoy being treasurer of a group.	.5194
I avoid tables and graphs in the newspaper.	.5772
If I have to change jobs/get a job,I won't try to get one that makes me work with numbers.	.5180
Positively Worded Items:	
I never get tired of using numbers.	.4826
I think about math problems and try to work them in my head.	.6781
I took elective math courses in school.	.4385
If a writer has used statistics to prove a point, I try to figure out his reasoning.	.4934
I keep a careful record of my expenses.	.4890
When I hear a math riddle I try to figure out the answer.	.5842

Desire for Competence=X1

Positively worded items:

It would make me happy to be recognized as excellent in mathematics.

I would be proud to be outstanding in math.

I'd be happy to get top grades in any course I might take in mathematics.

It would be really great to win a prize in math.

Being first in a math competition would please me.

Negatively worded items:

Being regarded as brilliant in mathematics would make me feel unpleasantly conspicuous.

People would think I were pretentious if I could do math problems quickly and easily.

If I did the best job of anyone in a situation using math, I'd prefer no one knew.

If I took courses in math and got good grades, I'd prefer not to let others know it.

It would make people like me less if I were really good in mathematics.

I don't like people to think I'm smart in math.

Teacher Scale=X2

Positively worded items:

I could have talked to my math teachers about a career in math.

My mathematics teachers were interested in my progress in mathematics.

My math teachers encouraged me to take all the math I could.

My teachers encouraged me to study more mathematics.

My teachers believed I'm the kind of person who could do well in math.

Negatively worded items:

I couldn't get math teachers to talk seriously with me about mathematics.

Getting a math teacher to take me seriously has been a problem.

When talking to my math teachers about anything serious, I used to feel ignored.

I found it hard to make math teachers respect me

My teachers would have thought I was not serious if I told them I wanted a career in science or math.

My teachers felt advanced math to be a waste of time for me.

Confidence in Learning Mathematics Scale=X3

Positively worded items:

I am sure that I can learn mathematics.

I think that I could handle more difficult math.

I am sure I could do advanced work in math.

I have a lot of self-confidence when it comes to math.

Generally I have felt secure about attempting mathematics.

I can get good grades in mathematics.

Negatively worded items:

I'm no good at mathematics.

Math has always been my worst subject.

For some reason, even when I study, math seems unusually hard for me.

Most subjects I can handle O.K., but I seem to make stupid mistakes in math.

I'm not the type to do well at math.

I do not think I could do advanced math.

Mathematics as a Male Domain Scale=X4

Positively worded items:

Women certainly are logical enough to do well in math.

Girls can do just as well in math as boys.

Studying mathematics is just as appropriate for women as for men.

I would trust a woman just about as much as I would trust a man to figure out important calculations.

Males are not naturally better than females in mathematics.

Females are just as good as males in advanced mathematics.

Negatively worded items:

When a woman has to solve a math problem, it is feminine to ask a man for help.

Girls who enjoy studying math are a bit peculiar.

I would expect a woman mathematician to be a masculine type of person.

Mathematics is for men; arithmetic, for women.

It is hard to believe a woman could be a genius at mathematics.

I would have more faith in the answer for a math problem solved by a man than by a woman.

Usefulness of Mathematics Scale=X5

Positively worded items:

I need a mastery of mathematics for my work.

I use/will use math in many ways in my life.

I'll need mathematics in my future work.

Mathematics is a worthwhile and necessary subject.

Knowing math would help me learn a living.

I would study math because I know how useful it is.

Negatively worded items:

Mathematics is not important to me in my life's work.

Taking mathematics courses is a waste of time.

I see mathematics as a subject I rarely use/will use in my daily life.

Mathematics is not relevant to life.

It was not important to me to do well in math in high school for what I wanted to do in my later life.

I expect to use math very little in my future.

Mother Scale=X6

Positively worded items:

My mother thinks/thought mathematics one of the most important subjects I studied.

My mother thinks/thought I could be good in math.

My mother thinks/thought I'd need math for what I wanted to do after school.

My mother has always been interested in my progress in mathematics.

My mother strongly encouraged me to do well in mathematics.

My mother thinks/thought of me as the kind of person who would do well in math.

Negatively worded items:

My mother wouldn't encourage me to plan a career using math.

My mother believes/believed I needed to know just a minimum of mathematics.

My mother hates/hated to do math.

My mother thinks/thought advanced math to be a waste of time for me.

As long as I passed, my mother never cared how well I did in mathematics.

My mother showed no interest in whether or not I took math courses.

Effectance Motivation in Mathematics Scale=X7

Positively worded items:

Mathematics is enjoyable and stimlulating to me.

Once I start trying to work on a math puzzle, I find it hard to stop.

I like math puzzles.

When a math problem arises that I can't immediately solve, I stick with it until I have the solution.

When a question comes up about math and does not get answered, I continue to think about it.

I am challenged by math problems I can't understand immediately.

Negatively worded items:

Math puzzles are boring.

The challenge of math problems does not appeal to me.

I dislike math puzzles.

Figuring out math problems does not appeal to me.

I don't understand how some people can spend so much time on math and seem to enjoy it.

I would rather have someone give me the solution to a difficult problem than have to work it out by myself.

Father Scale=X8

Positively worded items:

My father thinks/thought I'm the kind of person who could do well in mathematics.

My father thinks/thought I could be good in mathematics.

My father strongly encouraged me to do well in mathematics.

My father thought I'd need math for what I wanted to do after leaving school.

My father was always interested in my progress in mathematics.

Negatively worded items:

My father took no interest in whether or not I took more math courses.

My father hates/hated to do math.

My father thinks/thought advanced math to be a waste of time for me.

My father wouldn't encourage me to plan a career using math.

My father thinks/thought I need to know just a minimum of math.

As long as I passed, my father didn't care how I did in math in school.

Math Anxiety Scale=A1

Positively worded items:

I have usually been at ease when I am tested in some way in math.

I haven't usually worried about being able to solve math problems.

I almost never got upset during math tests.

It wouldn 't bother me at all to take more math courses.

When I've had to do math problems, I usually have been at ease.

Math doesn't scare me at all.

Negatively worded items:

A math test would scare me.

My mind goes blank and I am unable to think clearly when I think of trying hard math problems.

I get a sinking feeling when I think of trying hard math problems.

Mathematics usually makes me feel uncomfortable, restless, irritable, impatient.

Mathematics usually makes me feel uncomfortable and nervous.

Mathematics makes me feel uneasy and confused.

Subjects

Over 500 subjects from a variety of age groups and employed in a variety of occupations participated in the survey. The sample was gathered from Maryland, Pennsylvania, Virginia, West Virginia, New Jersey, and Delaware, and included people from ages 15 to 87, of whom 100 were classified white collar workers, 25 blue collar workers, 32 unemployed, 9 military personnel, 68 helping professionals, 69 in jobs requiring the use of math, 20 sales persons, 42 students, faculty and staff members in academic settings. White collar workers included secretaries and managerial positions; sales persons included realtors and clerks. Math jobs included math teachers, physicists, mathematicians, statisticians, and computer professionals. The sample included a few people who did not choose to reveal their sex; the rest were split 60% female/40% male. In all, there were 524 respondents with complete data.

By age, about 4% were over 65, 17% were between 45 and 65, 27% between 30 and 44, 23% were between 23 and 29, 17% were from 18-22, 1% were under 18, and 2% failed to state an age.

The response to the global questions indicated that 45% of the respondents believed they had studied much math, 45% did not and 10% were in the middle. Ten percent

also felt they used a median amount of math on the job, with the others split 45%/45% between high and low usage. Asked about the use of math in life, however, over 76% considered themselves to be frequent users, with only 15% responding they were not. About 67% of the sample felt they were good at using math, and about 23% did not.

Procedure

Four forms of the questionnaire were prepared. The 120 questions were assigned to places on the questionnaire by computer randomization; for each scale, counterbalancing was achieved by the presence of equal numbers of positively and negatively weighted items. A total of 1200 questionnaires were distributed and the return rate was approximately 50%. Those returned, however, were almost universally complete, and many contained thoughtful comments in the margins.

The completed survey instrument was prepared for distribution, including space for demographic information, careful instructions, and four global questions on page 1, followed by 7 pages of questions from the scales. Each page was headed with the correct definition of the scale numbers 1-5. The complete instrument was typed on legal paper, shrunk to 8 1/2 by 11 inch paper printed on both sides, causing the final form to contain only four sheets of professional- looking type. Each alternate form contained

its code (A-D) on each sheet. Subjects answered directly on the forms and were asked to provide an identifying number; either their social security number or one in similar form, thus securing anonymity.

CHAPTER 3

RESULTS

Examination of descriptive statistics for the various scales indicates that all scale means were somewhat higher than the expected mean of 36 (see Figure 1), which would be obtained if all 12 items received the median response of 3. However, only the male domain scale showed a statistically significant departure from the hypothesized distributions' mean, with a z score of 2.22, $p < .05$. A visual reduction of the male/female subscale profiles is presented in figure 1. Inspection of the figure indicates that females and males generally do not view math as a male domain, with females slightly less "male domain oriented" than males. Females show slightly more desire for competence in math than males, and are slightly less confident than males. In general, however, the profiles are remarkably similar across sexes.

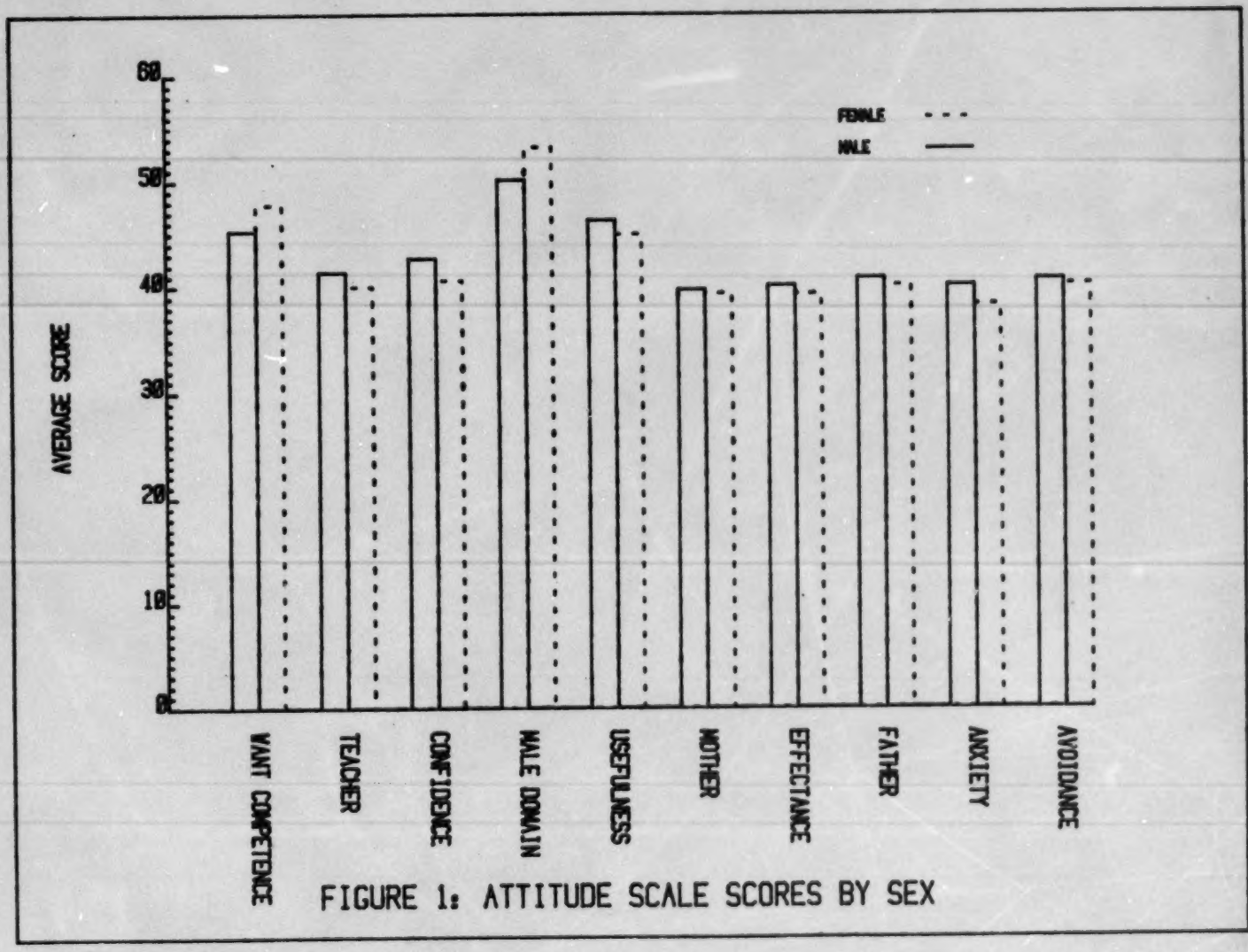

FIGURE 1: ATTITUDE SCALE SCORES BY SEX

TABLE 2: THE SAMPLE

SCALE	mean	mode	median	s.d.
want-competence	46.9	45	46.7	7.92
teacher	40.6	36	40.5	9.19
confidence	41.5	47	43.8	11.23
male-domain	52.0	60	53.1	7.19
usefulness	45.5	44	45.9	8.46
mother	39.5	36	39.3	8.35
interest	39.8	42	41.4	10.64
father	40.3	39	39.7	8.61
anxiety	39.1	46	41.3	11.89
avoidance	40.5	44	41.5	9.44

AGE	frequency
over-65	207
45-64	19
30-44	193
23-29	123
18-22	91
under-18	8
missing	9
-	
-	

Profession	frequency
white-collar	100
blue collar	25
unemployed	32
military	9
helping	68
math	69
sales	20
students	42
acedemics	150

Global Questions

1)Amount-studied	frequency
much	238
little	231
moderate	52
missing	3

2)Use on Job	frequency
much	236
little	235
moderate	50
missing	3

3)Use in Life	frequency
much	402
little	77
moderate	42
missing	3

4)Perceived skill	frequency
much	353
little	119
moderate	49
missing	3

SEX	frequency
males	207
females	314
missing	3

Multiple Regression Analysis

A stepwise multiple regression with sex, demographic information, and scores on nine predictor scales was performed in order to discover which of the scaled variables were reliable predictors of the MA score. The analysis revealed five significant predictors ($p < .05$). Note that the first scale shown in the regression analysis of Table 3, Effectance Motivation, by itself accounts for 74% of the variance in the criterion variable and the multiple R^2 for the set of five predictors is nearly 82%. None of the remaining variables was significant, although the sex by confidence interaction was also reliable. Including this interaction in the final regression, the multiple R was shown to be .9042, and accounts for very close to 82% of the variance in the avoidance measure. Table 4 gives all information for the final regression equation.

Discriminant Analysis

Although the sex variable was not a significant predictor of MA, past work has indicated that it is an important predictor. Therefore, a discriminant analysis was performed on scale scores to isolate the major differences between the sex groups. The results of this analysis are presented in Table 4. Results indicate females desired competence and did not see math as a male domain, but did not have as much confidence in their ability to learn it.

TABLE 3: Multiple Regression

Variable	B	Beta	Std.Err.	F
EM	.34023	.38350	.0326	108.67
Confidence	.19965	.23385	.0405	23.47
Usefulness	.15566	.14036	.0288	29.58
Anxiety	.15705	.19786	.0358	20.26
Father	.60632	.05502	.0237	6.45
Sex-by-Conf.	.83308	.03369	.0043	3.61
constant	.28165			

Variable	Mult R	R^2	R^2ch.	Simple r
E.M.	.85847	.73697	.73697	.85847
Conf.	.89167	.79508	.05810	.84731
Usef.	.89857	.80743	,01236	.67258
Anx.	.90237	.81428	.00684	.82033
Father	.90352	.81636	.00208	.46262
Sex-by-Conf	.90423	.81763	.00127	.22125

$p < .05$,df 6,517

To predict avoidance, in standard scores, the equation:
.3835 (Effectance Motivation) +.2339 (Confidence) +
.1404 (Perceived Usefulness) +.1979 (Anxiety) +
.0550 (Father Score) +.0367 (sex by confidence) =
Predicted Avoidance Score

Table 4:Discriminant Analysis

Pooled Within Groups Correlations

Between Discriminant Functions

and Discriminating Variables

Male-Domain	.5623
Desire-Competence	.3991
Confidence	-.2331

Canonical Discriminant Functions Evaluated

At Group Means (Group Centroids)

Males	-.4783
Females	.3153

CHAPTER 4

DISCUSSION

MAJOR FINDINGS

There are six major findings in the data, reported in the order of magnitude of effect:

Effectance Motivation

Effectance motivation, the best predictor of MA, accounts for the largest amount of variance in the avoidance measure. This finding accords with much previous research that indicated a relationship between MA and problem solving attitude.

Confidence in Learning Math

Confidence in learning mathematics predicts MA. The data suggest that the more confident one is, the less likely one is to avoid math. A related finding indicates that women are less confident in their abilitiy to use math, and do not perceive math to be as useful as their male peers perceive it.

Perceived Usefulness

The more useful the participants perceived math to be, the less they tended to avoid it. This finding is consistent in both males and females. In addition, there is also a strong relationship between perceived usefulness and effectance motivation (EM) (r=.8296). Although the finding

is correlational, it is tempting to speculate that perceived usefulness is a precursor to EM in math avoidance.

Math Anxiety

Math anxiety as a predictor of avoidance is ranked fourth in these data. This finding provides partial disclaimer to the popularly held notion that math anxiety and math avoidance are the variables most intimately related in the general population. It is safe to say that anxiety (one of nine predictor variables used in this study) was a significant predictor of MA and that this finding is consistent with the literature. A further breakdown of these data led to the conclusion that those who use math regularly in their work are less math anxious. Comparing math professionals to helping professionals, for example, reveals math professionals to be significantly less anxious, t (123)=14.53, p <.01. It is therefore reasonable to assume that math avoidance and math anxiety are not synonymous, and that the regular use of math may result in lessened math anxiety and avoidance.

Father Scale

Although the final main effect, the father variable, produced an increment in the multiple R^2 of only .0021, it is, nevertheless, significant. Those people who can report more positive factors relating to their fathers are less likely to avoid mathematics. This finding suggests a

modeling component to math avoidance. Moreover, the type of modeling appears comparable in each sex.

Interaction of Sex and Confidence in Learning Math

Although sex was not significant as a main effect, it interacted with the confidence variable to predict MA. Female confidence is significantly less than that of males. t (519)=14.33, $p < .01$. Females with low confidence tend to avoid math more than any of the remaining sex(male/female) by confidence(low/high) groups.

Other Variables

No other scales or interactions were significant predictors of MA, suggesting that some variables that have been investigated are not significantly related to MA. In summary, the largest correlate of MA is EM. Other potent predictors include the perception of the usefulness of math, math anxiety, relationship with father, confidence in learning math, and the interaction of confidence with sex. In addition, these variables appear to capture the overwhelming majority of the variance in MA (84%). Future investigations of MA should therefore limit their focus to exclude the relationships among these variables and MA.

Theory and Data: A Theory of Math Avoidance

Modeling theory does not receive strong support in these data. The only significant modeling variable was the

father scale (and this was the weakest of the set). Neither the mother scale nor the teacher scale proved significant as predictors of MA.

The "theory of the mathematical mind" suggests an intellectual "math type." These data neither support nor refute this notion since neither intellectual measures, performance, nor achievement variables were used as predictors of MA. The major problem with this theory is the difficulty of determining exactly which variables should be used in modeling the mathematical mind. In addition, there are no measures of "math-mindedness" currently available, and thus, no way of correlating this variable with MA. Finally, the theory does not specify any testable hypotheses, nor forms of remediation or therapy for the math avoider. The data provide support for Sells'(1973) critical filter model which indicates that early life events and decisions lead to reduced exposure to math and thus to MA. These data suggest that math avoiders lack EM, do not perceive math as useful, have little confidence in their abilities to learn math, and are "math anxious." This profile is consistent with an early "critical filtering" and long term avoidance of mathematics. Unfortunately, however, the critical filter model is not a theory of math avoidance, but a description of its development. It therefore does not lead to testable hypotheses nor

to prescription of effective remediation for the math avoider.

The theory of learned helplessness (Parente' & Chisholm, 1980; Seligman, 1976) is consistent with these data and fulfills the majority of the criteria for a theory of math avoidance. That is to say, the theory 1) is consistent with the data, 2) leads to clear predictions concerning MA, and 3) leads to effective treatment suggestions for math avoidance.

The largest predictor of MA is effectance motivation. This dimension is defined by Fennema and Sherman (1976) as motivational problem-solving mind-set which is a dimension ranging from lack of involvement to seeking challenge. It is not an indication of interest in using numbers. In other words, the motivated individual exhibits exploration and experimentation, while the math avoider appears passive. This individual may be the one who, having learned that he or she is helpless in dealing with numbers, has a motivational deficit analogous to that induced in the Seligman paradigm.

The second predictor of MA, confidence in learning math, corresponds directly to the cognitive deficit of learned helplessness. Seligman feels that his animals (or humans) exhibit a decreased ability to realize that situations can be controlled by them. For the "math helpless," the cognitive

deficit would most likely take the form of a faulty cognition that he cannot learn math.

Perception of the usefulness of math as a predictor of MA is not inconsistent with the theory. Perhaps the helpless individual must express a belief in the irrelevance of math to rationalize the seemingly irrational state of helplessness in which he/she is found. The reformulated learned helplessness theory which posits attributional components to the observable phenomenon would suggest just such a result.

The fact that anxiety was a significant predictor of math avoidance also supports the learned helplessness interpretation. Seligman's dogs demonstrated extreme anxiety while in a helpless state. Thus an individual, unable to control situations involving numbers, may decide the problem is global (extending to all numerical situations), stable (will continue in the same way), and internal (the result of personal failures).

The major advantage of the learned helplessness theory relative to the other explanations of MA that have been discussed is that it leads to several testable intervention strategies. First, an organism made helpless must be induced to respond. Seligman (1975) discovered that the only way to help the dogs exhibiting learned helplessness to learn

that it was possible for them to gain control over shock, was to forcibly drag them across the shuttle box. After many trials, it was possible for the dog to learn that such movement did control the shock. Unless the animal was forced to experience many trials with such success, he could not learn. As the dog must be dragged across the shuttle box, the avoider must be made to confront math and the confrontation must be structured to insure success. Along these lines, therapeutic use of solvable problems has been shown to effectively reduce the effects of induced helplessness (Hiroto & Seligman,1975).

Perhaps the most effective confrontation would entail "errorless discrimination," for example, by programmed text. Second, as Parente' and Chisholm (1980) noted, mathematicians themselves break problems down into tiny parts before attempting solutions. Individuals who have been reshaped to approach math must next be taught to adopt this strategy. Carefully designed programmed instruction in math may accomplish both goals. That is, the material is broken down into subparts which facilitate errorless learning. At the same time this type of learning material teaches the student to approach the material with a dissective strategy.

Finally, at a preventive level the theory suggests that all students should be "innoculated" against math

avoidance by a series of initially positive and rewarding experiences with the topic.

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